

Morphological differences of scales and gill rakers used as a taxonomic character in some thick-lip fish species (Family: Labridae), Red Sea, Egypt.

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ABSTRACT

The present study aimed to study the possibility of using the morphological features of scales and gill rakers as taxonomic characters in some thick-lip fish species, *Hemigymnus fasciatus* and *Hemigymnus melapterus*. Fishes were collected from land fish market in Hurgghada of Egyptian Red Sea, during the period from April 2016 to May 2017. The scales and the first gill arches of studied species were removed, stained and examined.

Scales of *H. fasciatus* and *H. melapterus* are mainly of cycloid type, triangular shape and they don't find on operculum (OOP) region. Scale margin is smooth in all regions in *H. fasciatus*, but it is convex in under pectoral fins in *H. melapterus*. Scale focus has oval shape in *H. fasciatus* and elongated oval shape in *H. melapterus*. Separation line has reversed V shape in all regions in first species and semi-striated shape in the caudal peduncle area in the second one. Granulation area of *H. fasciatus* has crescent shape but in *H. melapterus* it has triangle shape.

Gill rakers of the anterior row have sharp tips in *H. fasciatus* and but have forked tips in *H. melapterus*. Gill rakers of the posterior row have flower like shaped base in *H. fasciatus* and leaf or cup shaped base in *H. melapterus*. The anterior row has 22-23 gill rakers in *H. fasciatus* and it has only 20 gill rakers in *H. melapterus*. The posterior row has only 16 gill rakers in *H. fasciatus* and it has 18-20 gill rakers in *H. melapterus*.

In conclusion, the morphology of scales and gill rakers in *H. fasciatus* and *H. melapterus* can be used as diagnostic characters (finger print) in their classification.

INTRODUCTION

Family Labridae is one of the most interesting and numerically abundant fish families and it is the second most species-rich family of marine fish after Gobidae (Froese & Pauly, 2014). Species in this family were very widely distributed in marine waters; mostly from the coast line to about 160 m depth on sandy bottom, shallow coral and rocky reefs. Most wrasse species are carnivorous; feeding mainly on benthic invertebrates or fish. Some species are planktivores, corallivores and cleaners that feed on the ectoparasites of other fish (FAO, 1983; Randall, 1983; Gomon & Randall, 1984; Lieske & Myers, 1994, 2004; Allam *et al.*, 2005; Khalaf-Allah, 2013; AL-Zahaby, 2015 and Pradhan & Mahapatra, 2017). The labrid fish genus *Hemigymnus* (Günther, 1862) consists of three relatively large coral-reef species: the wide-ranging Indo-Pacific *H. fasciatus* (Bloch, 1792), *H. melapterus* (Bloch, 1791),

and *H. sexfasciatus* (Rüppell, 1835) were recorded from the Red Sea and Gulf of Aden. They are called thick-lip wrasses in reference to their very large, fleshy lips. Their principal mode of feeding consists of taking a mouthful of sand and detritus, releasing sand from the gill opening as they swim from the bottom, sorting the fossorial prey within the mouth and pharynx, and ejecting the larger inorganic fragments from the mouth. They also feed opportunistically on larger benthic prey (Randall, 2013).

Scale characteristics have been considered relevant for the fish taxonomy and phylogeny by many authors (Hughes, 1981; Chervinski, 1986; Chervinski & Shapiro, 1988; Lippitsch, 1991, 1992, 1993; Helfman *et al.*, 1997 and Osman, 2000). The considerable variation in scale shape on various parts of the body makes it difficult to nominate a typical scale for species to be used in taxonomic studies. However, some character states of the inter-radial denticles, cteni, and the focus area appear to be good taxonomic criteria (Jawad, 2005). Scales have numerous hidden details in their sculptural design that contributes effectively to fish identification and classification (Matondo *et al.*, 2010).

Scales have been used for classification, identification and growth in studies on different fish. Although all scales come in immediate contact with the environment and the pollutants, they have rarely been used as bioindicators of pollution (Tandon & Johal, 1993 and Babu *et al.*, 2014).

The pharynx, in teleost, was characterized by the presence of gill arches. These gill arches were located at the boundary between the pharyngeal cavity and the opercular chamber on both sides of the head. The gill arches in general were equipped with gill rakers toward their pharyngeal side and were considered to play an important role in feeding (Zayed & Mohamed, 2004; Kumari *et al.*, 2009 and Elsheikh, 2013).

There are one or two rows of gill rakers on each gill arch; one faces towards the mouth (anterior or oral row) and the other points to the opposite direction (posterior or aboral row). The anterior row at the first gill arch is more developed. The main function of the gill rakers is to prevent prey from escaping through the gills (Khanna, 1962). Gill rakers allow the solid food to go to gullet and only water can pass through gills to outside (Kumar & Tembhe, 1996).

The number of gill rakers is often used as a diagnostic character in studies on stock identification (Clayton & MacCrimmon, 1988), species identification (Almeida *et al.*, 2013) and as a character at lower taxonomic levels such as populations (Yokogawa & Seki 1995).

Scale surface morphology provides new and useful information on fish taxonomy. Several characters of scales such as type of scales, size, shape, and position of focus are established and being used as a taxonomic tool (Ansari *et al.*, 2016). Also, the number and shape of gill rakers can be used as diagnostic characters (finger print) in fish classification (Khalaf-Allah *et al.*, 2016).

Therefore, the present study aimed to describe the morphological differences in scales and gill rakers between two thick-lip fish species; *Hemigymnus fasciatus* and *H. melapterus* (Family: Labridae) inhabiting coral reef in Hurghada, Red Sea, Egypt.

MATERIALS AND METHODS

Specimens collection:

A total of 20 specimens of two thick-lip fish species (10 of Barred thick-lip, *Hemigymnus fasciatus* and 10 of Black eye thick-lip, *Hemigymnus melapterus*) were

seasonally collected from the commercial catch at land fish market in Hurghada of Egyptian Red Sea, during the period from April 2016 to May 2017. Fishes were freshly examined; standard and total lengths were measured to the nearest millimetres and recorded. Fish were preserved in 10% formalin solution and transported to the laboratory of Marine Biology, Zoology Department, Faculty of Science, Al-Azhar University, Cairo, Egypt, for latter examination.

Scales:

Staining of scales:

In the laboratory, for scale characteristic studies, scales of each sample were removed from the following four regions:

- 1- Directly below the anterior part of dorsal fin (BDF) (region A).
- 2- On operculum (OOP) if possible (region B).
- 3- Under pectoral fin (UPF) (region C).
- 4- Caudal peduncle area (CPA) (region D).

Scales were cleaned by physical careful removing the adhering tissues without damage the scale surface by immersing in 3% KOH for 2 hours, then transferred into 70% ethyl alcohol + 3% Alizarin red for 3 days. Finally, the scales were microscopically examined, photographed by using camera (model UCMOS 03100 KPA, China) mounted on binocular light microscope and described.

Examination and measurements:

The scales were microscopically examined under a binocular microscope. The digital photographic images were taken using a digital camera mounted on a dissecting microscope. From the digitalised images, the following measurements (Figure 1) were made by using the ocular micrometer:

1. Total length of scale (L).
2. Length of caudal field (L_1).
3. Length of radial region (Rostral field) of the dorsal field (L_2).
4. Scale Width (W).

Length of each measurement (L_1 , L_2 and W) is expressed as a percentage of total scale length.

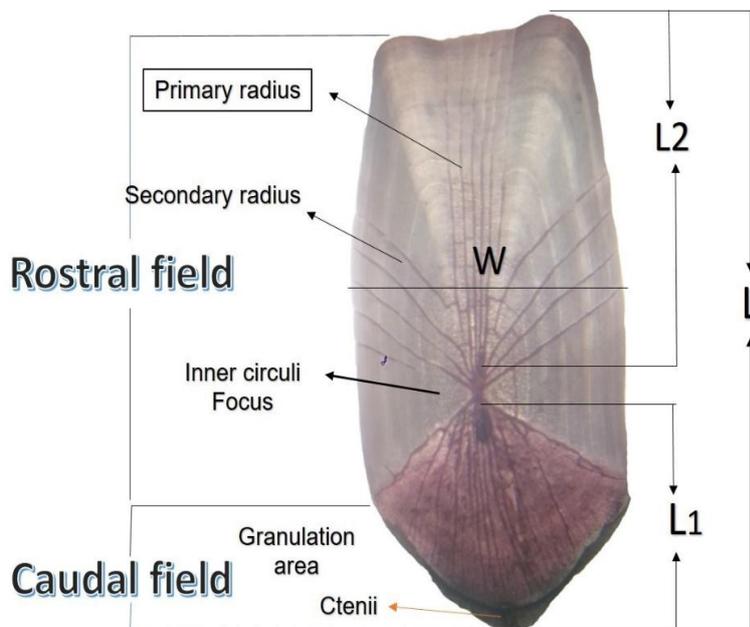


Fig. 1: Digital photograph of scale showing its measurements (total length of scale (L), length of caudal field (L_1), length of radial region (Rostral field) of the dorsal field (L_2) and scale width (W) in studied Labrid species.

Gills:**Staining of gill arch:**

In the laboratory, after carefully dissection, operculum was removed, the first gill arch in the left side of the fish was cut off from the rest of the gill and immersed in 70% ethyl alcohol + 3% Alizarin red for 24 hours, then it was washed in 1% KOH for 2 hours.

Examination and measurements:

The gill arch length (LGA) was measured using flexible wire to take gill arch curve and record its length on the ruler in millimeters. Gill arches were microscopically examined and the number of gill rakers was counted (RC) under a dissecting microscope. The digital photographic images were taken using a digital camera mounted on a dissecting microscope. From the digital images, the following measurements were made using the Image ProPlus Program:

1. The length of anterior gill rakers (LA_R): Distance from the tip to base of the longest and the 4 neighboring rakers were measured in (μm).
2. The breadth of anterior gill raker base (BA_B): Width base of the longest and the 4 neighboring rakers (μm).
3. The anterior inter-raker space (IA_R): Distance between the edge of each gill raker and the edge of the next gill raker in the longest and the 4 neighboring rakers (μm).
4. The length of anterior spinules (LAS): Distance between origin and end of spinules at gill rakers (μm) (if possible).

Statistical analysis:

Statistical analysis; ANOVA and t-test of data were conducted by using Microsoft Excel and SPSS under windows programs.

RESULTS**Scale morphology in thick-lip fish:*****Hemigymnus fasciatus*:**

Scales of *H. fasciatus* are mainly of cycloid type. Scales aren't found on operculum (OOP) region. The scale is triangular in shape and moderate in size with irregular margin and its surface is smooth in all regions. The position of focus is in caudal area and it has oval shape, with smooth surface in all regions. In the rostral part of scales, circuli are partitioned by several distinct grooves (radii) that run radially towards the focus. These radii are represented by three types as primary, secondary and tertiary. In the caudal field, the separation line has reversed V shape (\wedge); and the granulation area has a crescent shape in all areas, except in the caudal peduncle area, in which it has triangle shape (Plate I).

In *H. fasciatus*, the maximum percentage of length caudal field of scales attains 35.5 – 64.0 (average 46.5 ± 4.65 %) is recorded at caudal peduncle area (region D), and the minimum percentage (range= 32.6 - 54.4, average 43 ± 6.53 %) is recorded at under pectoral fins (region C). The highest percentage of length radial region of the rostral field of scales ranged between 42.4 - 63.9 with an average of 53.3 ± 6.48 % is recorded at under pectoral fins (region C), and the lowest percentage is attaining 32 - 60.7 (average 49.4 ± 7.7 %) at caudal peduncle area (region D). The lowest percentage of scale width attains 39.3 - 56.2 (average 45.4 ± 4.73 %) is record at below the anterior part of dorsal fin (region A), and the highest scale width occurred at under pectoral fins (region C), ranges from 56.9 - 68.3 with an average of 63.2 ± 3.65 % (Table 1).

Table 1: Scales measurements (%) in studied thick-lip fish species (Family: Labridae)

Regions	Measurements	<i>Hemigymnus fasciatus</i>		<i>Hemigymnus melapterus</i>	
		(Range)	Mean \pm SD	(Range)	Mean \pm SD
A	L ₁ /L (%)	(33-64.8)	45.4 \pm 9.31	(38.1-53.5)	46.7 \pm 4.71
	L ₂ /L (%)	(31.2-62.1)	50.1 \pm 9.05	(43.1-58.2)	50 \pm 4.66
	W/L (%)	39.3-56.2	45.4 \pm 4.73	(38.5-54.2)	46.2 \pm 5.04
C	L ₁ /L (%)	(32.6-54.4)	43 \pm 6.53	(37.1-47.3)	40.9 \pm 3.11
	L ₂ /L (%)	(42.4-63.9)	53.3 \pm 6.48	(50-60.2)	56.2 \pm 2.97
	W/L (%)	(56.9-68.3)	63.2 \pm 3.65	(44.8-66.8)	54.7 \pm 5.41
D	L ₁ /L (%)	(35.3-64)	46.5 \pm 7.65	(33.3-61.5)	44.1 \pm 8.04
	L ₂ /L (%)	(32-60.7)	49.4 \pm 7.7	(35.5-62.8)	52.8 \pm 7.87
	W/L (%)	(44-58.5)	50.7 \pm 3.43	(41.4-65.5)	48.1 \pm 5.27

L: total length of scale; L₁: length of caudal field; L₂: length of radial region of the dorsal field and W: Scale width

Hemigymnus melapterus:

The scales of *H. melapterus* are mainly of cycloid type and they aren't found on operculum (OOP) region. The scale is triangular in shape and moderate in size with margin shape is irregular in all regions, except in under pectoral fins is convex; and its surface is smooth in all regions. The position of focus is in caudal area and it has elongated oval shape with irregular surface in all regions. In the rostral part of scales, the circuli are partitioned by several distinct grooves that run radially towards the focus; they are called radii. Radii are represented by three types as primary, secondary and tertiary. In the caudal field, the separation line has a triangle shape in all regions, except in the caudal peduncle area, in which it has a semi-striated shape and the granulation area has a triangle shape (Plate I).

In *H. melapterus*, the maximum percentage of length caudal field of scales attains 38.1 - 53.5 (average 46.7 \pm 4.71 %) is recorded at below the anterior part of dorsal fin (region A) and the minimum percentage (range= 37.1 - 47.3, average 40.9 \pm 3.11 %) was recorded at caudal peduncle area (region D). The highest percentage of length radial region of the rostral field of scales attains 50 - 60.2 with an average of 56.2 \pm 2.97 % at under pectoral fins (region C) and the lowest percentage is attaining 43.1 - 58.2 (average 50 \pm 4.66 %) at below the anterior part of dorsal fin (region A). The lowest percentage of scale width attains 38.5 - 54.2 (average 46.2 \pm 5.04 %) is record at below the anterior part of dorsal fin (region A), and the highest occurred at under pectoral fins (region C), ranges from 44.8 - 66.8 with an average of 54.7 \pm 5.41 % (Table 1).

The statistical analysis in values of scales measurements in thick-lip fish group of family Labridae was performed by using analysis of variance (ANOVA). One-way ANOVA showed that significant differences (P<0.05) in regions in the percentages of L₁/L, L₂/L. While, in the percentages of W/L showed highly significant differences (P<0.01) in species and regions. Two way ANOVA showed that highly significant differences (P<0.01) in interaction between species and regions in the percentage of W/L (Table 2).

Gills in thick-lip fish:

The gill system in thick-lip fish, *H. fasciatus* and *H. melapterus* consists of four pairs of gills, which are termed from the lateral to medial as first, second, third and fourth gill arch. The first gill arch (outer) is the longest one. Each gill arch has bow-like shape and formed of one piece. It is displayed semi-lunar in shape, consisting of two limbs (upper and lower limbs). The gill arch carried gill rakers on its concave border and gill filaments on its convex one. The anterior row (oral row) and posterior (aboral row) of gill rakers varied in length and shape in the first gill arch; having long

and more developed rakers in the first row and short with less developed rakers in the second one (Plate II A&B).

Table 2: Analysis of variance (ANOVA) performed on measurements of scales recorded from different regions of studied thick-lip fish species (Family: Labridae)

Parameters	d. f.	F value		
		L ₁ /L	L ₂ /L	W/L
Species	1	0.314	0.18	21.78**
Regions	2	3.50*	4.08*	64.09**
Species * Region	2	2.11	1.806	7.77**
Error	54			
Total	60			

Where: *= significant at $p < 0.05$, **= highly significant at $p < 0.01$

Hemigymnus fasciatus:

The gill rakers of the anterior row on the first gill arch of *H. fasciatus* are relatively long, oval shape in base and elongated thick strips seem like flask with large rounded bases and sharp ends. The longest rakers are found at the middle of gill arch. It decreases gradually in length towards the upper and lower ends of gill arch. The inter-raker space is wide on the tips and narrow on the bases. Many fine spinules are found on the top and internal surface of gill rakers and directed towards the posterior gill rakers (Plate II A&C).

Data in Table (3) showed that, the average of standard length of *H. fasciatus* is 18.2 ± 3 cm. The average length of the first gill arch is 2.9 ± 0.9 cm. The number of gill rakers of the anterior row on the first gill arch ranges between 22 and 23. The average length of gill rakers is $304 \pm 68.3 \mu\text{m}$. The average breadth at the base of gill raker is $131.5 \pm 26.3 \mu\text{m}$. The average of inter-raker spacing is $88.1 \pm 25.6 \mu\text{m}$. The average length of spinules in anterior rakers is $39.4 \pm 9.3 \mu\text{m}$. The average gill raker length-gill arch length ratio is $10 \pm 2.3 \%$.

Table 3: Gill rakers measurements and counts of anterior and posterior rows on the first gill arch of the studied thick-lip fish species (family: Labridae).

Measurements and counts	Anterior gill rakers			posterior gill rakers		
	<i>Hemigymnus fasciatus</i>	<i>Hemigymnus Melapterus</i>	T test	<i>Hemigymnus fasciatus</i>	<i>Hemigymnus melapterus</i>	T Test
St. L (cm)	Range	13.9-21.6	15-28.5	-	-	-
	Mean \pm SD	18.2 ± 3	21.6 ± 4.6			
LG_A (cm)	Range	2.4-3.7	4.1-5.3	**		**
	Mean \pm SD	2.9 ± 0.7	4.8 ± 0.9			
RC	Range	22-23	20	**	16	18-20
	Mean \pm SD	22.2 ± 0.5	20 ± 0.01		16 ± 0.001	19 ± 0.9
LA_R (μm)	Range	168.1-414	482.7-701.5	**	65.1-92.9	87.2-136.7
	Mean \pm SD	304 ± 68.3	599.3 ± 72.9		75.8 ± 7.8	116.7 ± 15.3
BA_B (μm)	Range	93.5-172.6	125.2-214	**	41.9-101.3	47.8-108
	Mean \pm SD	131.5 ± 26.3	154.2 ± 24.1		64.9 ± 19.3	69.3 ± 19.2
IA_R (μm)	Range	64.7-166.8	53-94.3	NS	58.8-131.3	90.2-147.1
	Mean \pm SD	88.1 ± 25.6	75 ± 12.4		91.1 ± 18.9	115.6 ± 16.5
LA_S (μm)	Range	30.2-63.1	53.6-87.5	**	22.4-62.9	44.8-76.9
	Mean \pm SD	39.4 ± 9.3	70.5 ± 8.9		42.8 ± 13	58.5 ± 9.9
LA_R/L	Range	5.5-14.2	9.2-13.3	*	1.8-3.2	1.8-2.5
	Mean \pm SD	10 ± 2.3	11.9 ± 1.1		2.5 ± 0.5	2.3 ± 0.1
G_A (%)	Mean \pm SD	10 ± 2.3	11.9 ± 1.1		2.5 ± 0.5	2.3 ± 0.1

St. L: Standard length of fish, RC: Gill rakers counts, LG_A: length of gill arch, LA_R: length of gill rakers in anterior row, BA_B: breadth at anterior base of rakers, IA_R: Inter raker space of anterior row, LA_S: Length of spinules at anterior row of gill rakers. (*= significant at $p < 0.05$, **= highly significant at $p < 0.01$ and NS = non-significant).

The gill rakers of the posterior row on the first gill arch of *H. fasciatus* are short, small and have flower like shape with blunt ends. The top of rakers have a lot of spinules (PLATE II A&E). The number of gill rakers of the posterior row on the first gill arch is 16. The average length of rakers is $75.8 \pm 7.8 \mu\text{m}$. The average breadth at the base of gill raker is $64.9 \pm 19.3 \mu\text{m}$. The inter-raker spacing average is $91.1 \pm 18.9 \mu\text{m}$. The average length of spinules in posterior rakers is $42.8 \pm 13 \mu\text{m}$ and the average gill raker length-arch length ratio is $2.5 \pm 0.5 \%$ (Table 3).

***Hemigymnus melapterus*:**

The gill rakers of the anterior row on the first gill arch of *H. melapterus* are long, flask in shape; oval in base and elongated thick strips with large round bases and fork ends. The longest and large rakers are found at the middle of gill arch and then it decreases gradually in length towards the upper and lower ends of gill arch. The inter-raker space is wide on the tips and narrow on the bases. The anterior gill rakers have a lot of spinules on the top and internal surface of each raker and directed towards the aboral row (Plate II B&D).

Data in Table (3) showed that, the average standard length of *H. melapterus* is $21.6 \pm 4.6 \text{ cm}$. The average length of the first gill arch is $4.8 \pm 0.7 \text{ cm}$. The number of gill rakers of the anterior row on the first gill arch is 20 and the average length of rakers is $599.3 \pm 72.9 \mu\text{m}$. The average breadth at the base of gill raker is $154.2 \pm 24.1 \mu\text{m}$. The inter-raker spacing average is $75 \pm 12.4 \mu\text{m}$. The average length of spinules in anterior rakers is $70.5 \pm 8.9 \mu\text{m}$ and the average gill raker length-arch length ratio is $11.9 \pm 1.1 \%$.

The rakers of the posterior row on the first gill arch of *H. melapterus* are short, small in size and leaf or cup in shape with thin base and blunt tips. The top of rakers have a lot of spinules (Plate II B&F). The number of gill rakers of the posterior row on the first gill arch ranges between 18 and 20. The average length of rakers is $116.7 \pm 15.3 \mu\text{m}$. The average breadth at the base of gill raker is $69.3 \pm 19.2 \mu\text{m}$. The inter-raker spacing average is $115.6 \pm 16.5 \mu\text{m}$. The average length of spinules in anterior rakers is $58.5 \pm 9.9 \mu\text{m}$ and the average gill raker length-arch length ratio is $2.3 \pm 0.1 \%$ ((Table 3).

The statistical analysis in values of gill rakers measurements in thick-lip fish group of family Labridae was performed by using t test analysis. T-test analysis showed highly significant differences ($P < 0.01$) in most measurements between species. In inter raker space of anterior rakers and in breadth at anterior base of rakers, length of spinules of posterior rakers was non-significant (Table 3).

Diagnostic characters between studied species of thick lip fish:

Results in Table (4) summarized the morphological differences between the studied thick-lip fish species (*H. fasciatus* and *H. melapterus*) in both scale features and gill rakers characters. These morphological differences can be used as diagnostic characters between these two species. Results showed that the scale margin is smooth in all regions in *H. fasciatus*, but it is convex in under pectoral fins in *H. melapterus*. Scale focus has oval shape in *H. fasciatus* and elongated oval shape in *H. melapterus*. Separation line has reversed V shape in all regions in first species and semi-striated shape in the caudal peduncle area in the second one. The granulation area of *H. fasciatus* has crescent shape but in *H. melapterus* it has triangle shape.

Gill rakers of the anterior row have sharp tips in *H. fasciatus* and they have forked tips in *H. melapterus*. Gill rakers of the posterior row have flower like shaped base in *H. fasciatus* and they have leaf or cup shaped base in *H. melapterus*. The anterior row has 22-23 gill rakers in *H. fasciatus* and it has only 20 gill rakers in *H.*

melapterus. The posterior row has only 16 gill rakers in *H. fasciatus* and it has 18-20 gill rakers in *H. melapterus* (Table 4).

Table 4: Morphological differences in scales and gill rakers in studied thick-lip species

Items		<i>Hemigymnus fasciatus</i>	<i>Hemigymnus melapterus</i>	
Scales	Shape	Triangular	Triangular	
	Margin	- Irregular shape and smooth in all regions.	- Irregular shape and smooth in all regions, except in under pectoral fins is convex in shape	
	Focus	- Caudal area in position and oval in shape. - Smooth surface.	- Caudal area in position and elongated oval in shape. - Irregular surface.	
	Separation line	- Reversed V- shape	- Triangle shape in all regions, and semi-striated shape in caudal peduncle rea,	
	granulation area	- Crescent shape.	- Triangle shape.	
Gill rakers	Shape	Anterior row	- Long with sharp tips	
		Posterior row	- Short with flower like shaped base and blunt tips	
	Number	Anterior	22 – 23	20
		Posterior	16	18 – 20

DISCUSSION

In the present study, scales collected from thick-lip fish were mainly of cycloid type and don't found on operculum (OOP) region. The scale is triangular in shape and moderate in size. Shape, margin, focus, radii, separation line and granulation area of scales in different regions of fish body may constitute as criteria for differentiation between the studied thick-lip fish, *H. fasciatus* and *H. melapterus*. These results are matching with Matondo *et al.* (2010). They mentioned that, traditional identification of scale structures revealed the presence of focus, circuli, lateral line canals, radii, lateral fields, posterior fields, anterior field, and shapes of scales.

Ganzon *et al.* (2012) mentioned that, the scale morphology provides new and useful information for systematics. Scales have numerous hidden details in their structures that contribute effectively to fish identification and classification. In the present study, the scales have irregular margin in all regions in the two studied species, except in under pectoral fin region of *H. melapterus*, in which they have convex shape.

Jawad (2005) mentioned that considerable variation in scale shape on various parts of the body makes it difficult to nominate a typical scale for species to be used in taxonomic studies. However, some character of the inter-radial denticles, cteni, and the focus area appear to be good taxonomic criteria. In the present study, the scale focus is caudal area in position and has oval shape in *H. fasciatus* and elongated oval shape in *H. melapterus*.

In the present study, in the rostral part of scales in two studied species, the circuli are partitioned by several distinct grooves that run radially towards the focus; they are called radii. Radii are represented by three types as primary, secondary and tertiary. Similar observations were detected by Esmaeili & Gholami (2011). They observed that three types of radii were commonly. The primary radii originating from the focus reaching to the margin of the scale, the secondary radii originating mid way between the focus and the margin and tertiary radii from margin not reached to focus.

The present study in the caudal field of scales, the separation line has reversed V shape (^) in *H. fasciatus* and but in *H. melapterus*, it has a triangle shape in all

regions, except in the caudal peduncle area, in which it has a semi-striated shape. The granulation area has a crescent shape in *H. fasciatus*, except in the caudal peduncle area, in which it has triangle shape; but in *H. melapterus*, the granulation area has a triangle shape. These results confirmed the conclusion of Esmaili *et al.* (2014), who mentioned that, the scale surface morphology and microstructure may help in distinguishing the species.

The present results of the shape and number of gill rakers on the first gill arch showed that they can be used in differentiation between the two studied thick-lip fish, *H. fasciatus* and *H. melapterus*. Also, Khalaf-Allah *et al.* (2016) mentioned that the morphological structures and count of gill rakers in the first gill arch were differed in four sparid fish species (*Sparus aurata*, *Diplodus noct*, *Rhapdosargus haffara* and *Boops boops*) and they concluded that these structures are suitable as distinct taxonomic characters.

In the present study, gill rakers of the posterior row on the first gill arch in two species were shorter and less in numbers compared to those on the anterior row. Similar observations were recorded by Berry & Low (1970), Lammens *et al.* (1986) and Khalaf-Allah *et al.* (2016) in other species.

Amundsen *et al.* (2004) mentioned that the morphology of gill rakers were correlated to the raker number and exhibited distinct differences between the morphs. The gill raker number and morphology appear to be a reliable marker for identifying ecologically and genetically in different European whitefish morphs. In the present study, rakers of the posterior row at the first gill arch of *H. fasciatus* were short, small and flower like shape with blunt ends contain spinules. While in *H. melapterus*, rakers of the posterior row in the first gill arch were short, small in size and leaf or cup in shape with thin base and blunt tips contain spinules. T test analysis showed highly significant differences ($P < 0.01$) in most measurements between species.

In the present study, the number of gill rakers in the first gill arch was varied from one species to another. The number of gill rakers on the anterior row of the first gill arch ranged between 22 and 23 for *H. fasciatus* and 20 for *H. melapterus*. The number of gill rakers on the posterior row of the first gill arch is 16 for *H. fasciatus* and ranged between 18 – 20 for *H. melapterus*. Similar observations were recorded by Randall (2013). Thus, this character could be used as a taxonomic feature.

CONCLUSION

The morphological scales and gill rakers in Barred thick-lip, *Hemigymnus fasciatus* and Black eye thick-lip, *Hemigymnus melapterus* can be used as diagnostic character (finger print) in their classification.

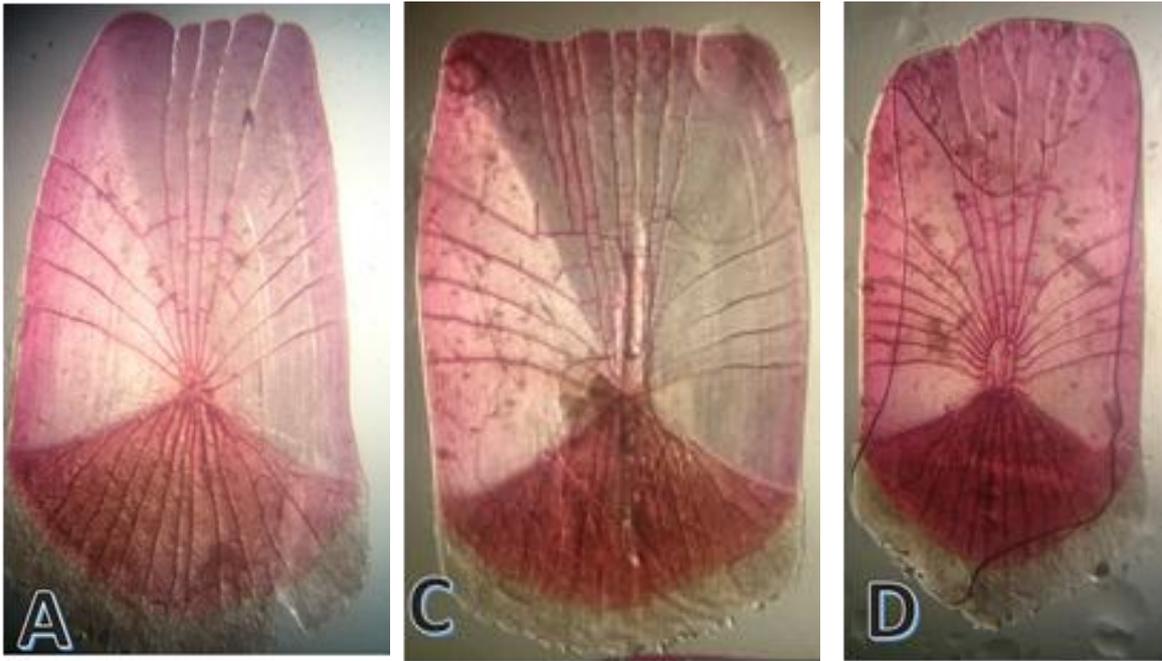
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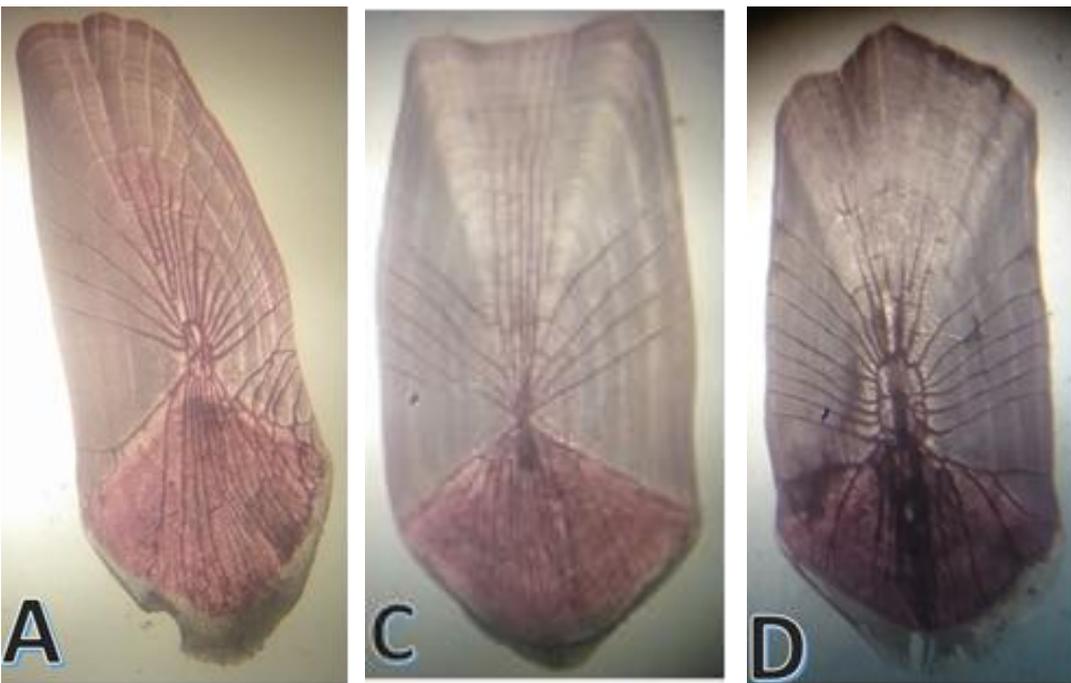
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Hemigymnus fasciatus



Hemigymnus melapterus

Plate 1: A Photomicrograph of scales in *H. fasciatus* and *H. melapterus* showing morphological structure of scales in different regions (A: below the anterior part of dorsal fin, C: under pectoral fin and D: caudal peduncle area).

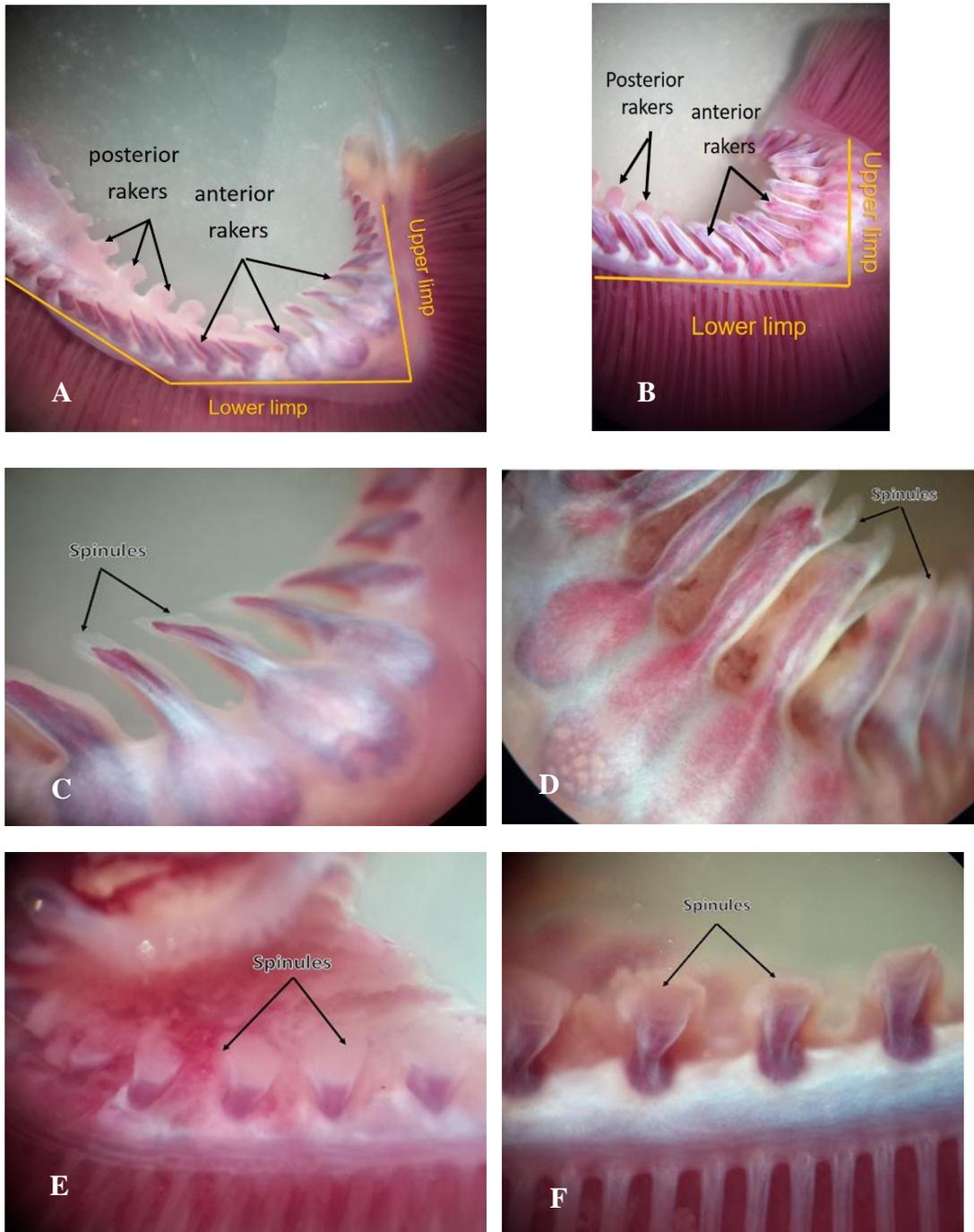
*H. fasciatus**H. Melapterus*

Plate II: Photomicrographs of the first gill arch of *H. fasciatus* and *H. melapterus* showing morphological structure of gill rakers (A & B), gill rakers of anterior row (C & D) and gill rakers of posterior row (E & F)

ARABIC SUMMARY

الإختلافات المورفولوجية للقشور والأسنان الخيشومية المستخدمة كصفات تصنيفية في بعض أنواع أسماك غليظة الشفافة (عائلة: الملاص)، البحر الأحمر، مصر

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تهدف هذه الدراسة إلى إمكانية استخدام السمات المورفولوجية للقشور والأسنان الخيشومية كصفات تصنيفية في بعض أنواع الأسماك غليظة الشفاه، أسماك الملاص غليظة الشفافة مخطط (هيميجيمنس فاشياتس) وأسماك الملاص غليظة الشفافة ذات العيون السوداء (هيميجيمنس ميلابترس). جمعت الأسماك من منطقة الإنزال في الغردقة بالساحل المصري للبحر الأحمر، خلال الفترة من أبريل 2016 إلى مايو 2017م. القشور والقوس الخيشومي الأول لهذه العينات تمت إزالتها وصبغها وفحصها.

أوضح فحص القشور لجميع مناطق الجسم في أسماك الملاص غليظة الشفافة مخطط وأسماك الملاص غليظة الشفافة ذات العيون السوداء أنها من النوع الدائري ولا توجد في منطقة الرأس وغطاء الخياشيم. القشور في نوعي الدراسة لها حافة غير منتظمة، باستثناء تحت الزعنفة الصدرية في أسماك الملاص غليظة الشفافة ذات العيون السوداء، والتي يكون لها شكل محدب.

بين فحص القشور أن شكل الموضع البؤري بيضاوي في أسماك الملاص غليظة الشفافة مخطط وبيضاوي مطول في أسماك الملاص غليظة الشفافة ذات العيون السوداء. الخط الفاصل في المنطقة الذيلية للقشور علي شكل V معكوسة (\wedge)؛ ومنطقة التحبيب لها شكل هلال في أسماك الملاص غليظة الشفافة مخطط، ما عدا في المنطقة الذيلية كانت مثلثية الشكل؛ ولكن في أسماك الملاص غليظة الشفافة ذات العيون السوداء، فإن الخط الفاصل له شكل مثلثي في قشور جميع مناطق الجسم، باستثناء المنطقة الذيلية، حيث يكون له شكل شبه مستوي ومنطقة التحبيب لها شكل مثلثي.

تعتبر الأسنان الخيشومية في الصف الأمامي على القوس الخيشومي الأول في أسماك الملاص غليظة الشفافة مخطط تبدو مثل قارورة ذو نهايات حادة. بينما في أسماك الملاص غليظة الشفافة ذات العيون السوداء، فإنها قارورية الشكل وذو نهايات مشقوقة. والأسنان الخيشومية في الصف الخلفي على القوس الخيشومي الأول تشبه الزهرة في أسماك الملاص غليظة الشفافة مخطط. أما في أسماك الملاص غليظة الشفافة ذات العيون السوداء فتشبه الأوراق أو الكأس في الشكل.

يتراوح عدد الأسنان الخيشومية للصف الأمامي في القوس الخيشومي الأول بين 22 و 23 وللصف الخلفي 16 في أسماك الملاص غليظة الشفافة مخطط، ويكون 20 للصف الأمامي في القوس الخيشومي الأول، والصف الخلفي يتراوح بين 18 و 20 في أسماك الملاص غليظة الشفافة ذات العيون السوداء.

الخلاصة:

خلصت الدراسة الحالية إلى أنه يمكن استخدام السمات المورفولوجية لكل من القشور والأسنان الخيشومية كصفات تصنيفية (بصمات الأصابع) في التفريق بين أسماك الملاص غليظة الشفافة مخطط و أسماك الملاص غليظة الشفافة ذات العيون السوداء.